and results of research in all departments, could be usefully brought forward at these meetings and receive illumination from discussion by those in authority. Are our anatomists and physiologists less willing to make such efforts than other scientific men, or have they a greater fondness for remaining in their own special haunts without emerging on any common ground?

Department of Anthropology.

Miss A. W. Buckland, of Bath, read a paper *On Rhabdomancy and Belomancy*, in which she endeavoured to show that rhabdomancy, or divination by means of a rod, still practised in England in some localities, was a survival of a very ancient superstition, originating in the use of rods as symbols of power.

Mr. John Evans described fully the proposed code of symbols for archæological maps which has been drawn up by a committee of leading archæologists on the continent of Europe, and will probably be extensively used. Suggestive crude symbols are adopted for the leading varieties of ancient remains, and a series of modifications of each chief form is to be used, to denote as far as possible the exact nature of the remains.

Mr. Hyde Clarke furnished a notice of the prehistoric names of weapons, in continuation of a note laid before the British Association in 1873, which showed that there was a community of aboriginal names of weapons in the prehistoric epoch. He now added that further research had confirmed these views.

Mr. Hyde Clarke also read a paper *On Prehistoric Culture in India and Africa*. After referring to his investigations as to the evidence of the successive migration and distribution of languages in Asia, Africa, North, Central, and South America, and in some cases in Australia, he proceeded to give the result of later special investigations as to the community of culture in India and Africa. The philology of the aboriginal languages of India could only be effectually studied from those of Africa, and Mr. Hyde Clarke suggested that it would be a great advantage if some of the missionaries of the two regions could interchange stations.—Prof. Rolleston remarked upon the desirableness of a complete work being prepared on the present ethnology of India, under the superintendence and at the cost of the Indian Government.

Dr. Phené, in his paper *On the Works, Manners, and Customs of the Prehistoric Inhabitants of the Mendip Hills*, adopted the theory of a similarity of race in the people who formerly occupied the caves on the Atlantic seaboard of Europe and of Britain; and identified the inhabitants of the Mendips with them.

Mr. D. Mackintosh read a paper *On Anthropology, Sociology, and Nationality*, which referred especially to distinctions of race in the British Isles, and defended his previously expressed views. He believed that the various colonising tribes had either continued in certain localities with little interblending, or that the process of amalgamation had not been sufficient to prevent the persistence of the more hardened characteristics. He tried to show that between the north-east and south-west the difference in the character of the people, irrespectively of circumstances, is so great as to give a semi-nationality to each division—restless activity, ambition, and commercial speculation predominating in the north-east, and contentment and leisurely reflection in the south-west.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—DETROIT MEETING.

LAST week we gave a general account of the meeting of the American Association, from an American correspondent. The following are brief notices of some of the principal papers read.

We have already referred to the presidential address of Prof. Le Conte, and to the address of Prof. Dawson, both of which were anti-evolutionary, the latter more distinctly so than the former. Prof. Dawson's views are so well known that we need not refer at length to his Association address.

Prof. Augustus R. Grote, Director of the Museum of the Buffalo Academy of Sciences, undertook the task of throwing light upon past geological eras by showing the present distribution of certain North American insects. He described the glacial epoch as occurring at the close of the Tertiary by a continuous loss of heat. The winters gradually lengthened, the summers shortened. The tops of mountains that now bear foliage were then covered with snow, which, in time consolidating, formed glacial ice that flowed into the valleys. Gradually an icy sea extending from the north spread southward, even over the Southern States and down the Valley of the Mississippi. Existing insects of the Pliocene, no matter how gradually they were affected by the change, must have eventually left their haunts, and doubtless many species were exterminated. At the present day there are found in the tops of the White Mountains, and in the lofty ranges of Colorado, certain species of butterflies and moths which are completely isolated. To find others of the same kinds we must explore the Plains of Labrador and the northern portions of our continent; there and there only do we find similar or analogous species. A White Mountain butterfly, *Oeneis Semidea*, was cited as an instance in point, and other butterflies and moths were mentioned, whose isolated habitats served to prove the general proposition. The retirement of the glacial seas at the close of the epoch was then considered. Then the summers were lengthening, while the winters were shortened. Then ice-loving insects, such as the White Mountain butterfly, hung on the edge of the ice sheet which supplied their food, and followed its retreat—not all, but some of their forms surviving. Straying upon the local glaciers of the mountain ranges, they were left behind in some instances, while the main body followed the retiring ice sheet to the far north. Those that were left behind still find the conditions of their existence in the snow-covered summits of the present day. As the valleys became warmer and glaciers fewer, the chances of their escape from their isolated positions gradually diminished till their removal became impossible.

Prof. E. S. Morse, of Salem, Mass., has for a long time made a study of the bones of embryo birds. At this meeting he recalled briefly the evidence he had shown last year regarding the existence of the intermedium in birds by citing the embryo tern, in which he had distinctly found it. This year he made a visit to Grand Menan expressly to study the embryology of the lower birds, and was fortunate in finding the occurrence of this bone in the petrel, sea-pigeon, and eider duck. This additional evidence showed beyond question the existence of four tarsal bones in birds, as well as four carpal ones. In these investigations he had also discovered embryo claws on two of the fingers of the wing—the index and middle finger. Heretofore in the adult bird a single claw only had occurred in a few species, such as the Syrian blackbird, spur-winged goose, knob-winged dove, jacana, mound bird, and a few others, and in these cases it occurred either on the index or middle finger or on the radial side of the metacarpus. All these facts lent additional proof of the reptilian affinities of birds.

Prof. S. P. Langley, of Alleghany Observatory, detailed some of the conclusions at which he had arrived after years of study of the solar surface. Prof. Langley first showed by comparative experiments that an absorptive atmosphere surrounds the sun. Little attention has in recent years been paid to the study of this atmosphere. The earlier efforts to tabulate its absorptive power, produced with different observers, though men of eminence, strangely discordant results. Their methods and deductions were given in detail. Secchi's results, making the neighbourhood of the edge of the sun about half the brightness of the centre, are probably near the fact. Prof. Langley applied well-known photometric methods to the problem. By attaching a circle of cardboard to the equatorial telescope, a solar image is received on the board, plainly showing spots, penumbræ, &c., if the image be one foot in diameter. From holes in this cardboard, pencils of rays issue, which being caught on a screen give a second series of images. If these images are caught upon separate mirrors, instead of a screen, their relative light can be made the subject of comparison with that of a disc of flame from Bunsen's apparatus, and thereby their relative intensity determined. Between each aperture and its respective mirror a lens was interposed which concentrated the pencil of rays. By suitable additions this apparatus can be converted to a Rumford photometer, and in this form it proved most available in Prof. Langley's hands. He found a value for the brilliancy of the umbra in sun-spots, considerably higher than that hitherto computed. The blackest umbra, he finds, is betweeen 5,000 and 10,000 times as bright as the full moon. The light of the sun is absorbed by its atmosphere not in the same, but in a greater proportion than its heat. A long series of experiments shows that not much more or less than one-half of the radiant heat of the sun is absorbed or suffers internal reflection by the atmosphere of the sun itself. Observations indicate that this atmosphere is (speaking comparatively) extremely thin; Prof. Langley is inclined to regard it as identical with the "reversing layer" observed by Dr. Young,

of Dartmouth, at the base of the chromosphere, though the chromospheric shadow should perhaps be taken into the account. The importance of a study of this absorbent atmosphere becomes evident if we admit that the greater part of the 500° which separate the temperature of the temperate zone from absolute zero is principally due to the sun's radiation. To this atmosphere new matter is constantly being added and taken away by the continual changes of the interior surface. Any alteration in the capacity for absorption—say a difference of 25 per cent., which could hardly be recognised by observation—would alter the temperature of our globe by 100°. The existence of life on the earth is clearly dependent on the constancy of the depth and absorption of this solar envelope. Hitherto we have chiefly confined calculations to the diminution of solar heat by contraction of the sun's mass—an operation likely to go on with great uniformity. But here is an element of far more rapid variation. If changes in the depth of this solar envelope are cyclical, they would be accompanied by cyclical alterations of earth's temperature. This may serve alike to explain the characteristics of variable stars and the vast secular changes on earth indicated by geology. If the law of alterations in that envelope can be ascertained, new light may be shed on the history of the globe and the near future of life upon it.

Prof. Thomas Meehan, of Germantown, Penn., made an attack on Darwinian theories in a paper which disputed the assumption that insects are a material aid in the fertilisation of plants. He drew the following conclusions: (1) That the great bulk of coloured flowering plants are self-fertilisers. (2) That only to a limited extent do insects aid fertilisation. (3) Self-fertilisers are in every way as healthy and vigorous, and are immensely more productive, than those dependent on insect aid. (4) That when plants are so dependent they are the worse fitted to engage in the struggle for life—the great underlying principle in natural selection.

Prof. Morse described the evident characteristics of insects which seemed not only fitted for fertilisation, but were found actually engaged in the process. He was not prepared to abandon the vast mass of facts already obtained on account of the few and doubtful experiments detailed by Prof. Meehan. Prof. Riley thought that the fact that insects were absolutely essential to the existence and perpetuation of many plants, had been proved by experiments and observations so numerous and convincing that it could no longer be denied. He mentioned his own experiments with the *Yucca;* and he met and combated the theory that self-fertilisation, like interbreeding, did not tend to deterioration. Prof. Meehan, in explanation of his views, stated that he regarded the present dependence of plants upon insects as an evidence of weakness and accident, or of deformation in the plant. Prof. Riley said that it was a mistake to suppose that insect life was scarce in the Rocky Mountains.

A paper was presented *On some New Fossil Fishes and their Zoological Relations*, by Prof. J. S. Newberry, of Columbia College, giving brief descriptions of interesting fish remains found during the past year in the Devonian and Carboniferous rocks of Ohio. Of these, the most important "find" was that of nearly the entire bony structure of a single individual of *Dinichthys Terrellii*, the hugest of all the old armour-plated Ganoids. Life-size drawings of most of these bones were exhibited to the Association, and copies of them will appear in the second volume of the "Geology of Ohio," now going through the press. Drawings of another species of *Dinichthys* was shown (*D. Hertzeri*) in which the maxillaries and mandibles are set with teeth instead of being sharp-edged. The remains of both these monsters have been found only in the upper Devonian rocks of Ohio. Prof. Newberry also exhibited to the Association teeth of *Dipterus Glenodus*, and those of a new genus belonging to the same family.

Prof. E. D. Cope, of Philadelphia, made a communication *On the Indications of Descent exhibited by North American Tertiary Mammalia.* The gradual development from one form to another by changes in the foot bones was traced through a long series from extinct Tertiary animals to those of the present day. A similar process of change was traced in the teeth of animals, the simpler forms of teeth in the Eocene being a crown with four tubercles. The human skeleton, Prof. Cope declared, retained many more ancient types than other Mammalia.

A paper from Prof. Daniel Kirkwood, of Bloomington, Ind., *On the Distribution of the Asteroids*, was read by Prof. Langley. Prof. Kirkwood stated that twenty years ago, when the number of known asteroids did not exceed fifty, it was inferred from purely physical considerations that there must be great irregularity in their distribution, and that gaps would be found in their zone where their periods were commensurable with those of the planet Jupiter. In 1866, when the number of asteroids amounted to eighty-eight, the agreement of theory and observation in this matter was the subject of a paper from Prof. Kirkwood, read at the Buffalo meeting of the Association, and the evidence was again summed up in a paper at Indianopolis in 1871. Since then thirty-one asteroids have been added to the group. It is now proposed to show that the truth of the theory advanced in 1866 is now more than ever determined. The Professor proceeds to divide the space between the asteroids into six zones by orbits whose periods would be commensurate with those of Jupiter. Then taking the members of the group in the order of their mean distances, it is found that the widest intervals between them are at these gaps where orbits would coincide with certain multiples of Jupiter's revolution. He remarks that it is a notable fact in the development of the solar system that the largest planet, Jupiter, should be succeeded by a space so nearly destitute of matter as the zone of the asteroids, the ratio of masses being as 1 to 5180. An explanation of the disproportion was given in a paper read in 1870; but it may be asked what might have been the result if the density of the asteroidal group had been equal to that of the other planetary rings. For reasons which he assigns, Prof. Kirkwood believes that if the asteroidal group had possessed a total density half that of Jupiter, they would when nebulous have been brought so closely into contact by the great planet's attraction as to fuse into one, instead of remaining as separate bodies. A similar result he regards as having taken place in the case of Uranus. A formation of the same kind would result where the period of a planet was one-third that of Jupiter; corresponding to the ratio between the periods of Jupiter and Saturn. The rare instances of great inclination among asteroids' orbits he is inclined to believe may have been occasioned by comets, when the minor planets were themselves in a cometary or nebulous condition.

The Hon. L. H. Morgan, of Rochester, read papers *On Ethnical Periods and the Arts of Subsistence.* The discussion of ethnology would be much facilitated by the use of a certain number of ethnical periods representing conditions in the advance of man from his earliest to his higher conditions. Mr. Morgan proposes the following:—

1. A period of savagery.
2. The opening period or lower status of barbarism.
3. The middle period of barbarism.
4. The closing or upper period of barbarism.
5. The period of civilisation.

The ages of stone, bronze, and iron have served a useful purpose in archæology, but the progress of knowledge has rendered more definite subdivisions necessary. The use of stone implements began far back in savagery, which extended even to the introduction of tools of iron. The successive arts of subsistence offer distinctions of more value. The period of savagery begins with the human race. The invention or practice of the art of pottery may enable us to draw the line between savagery and barbarism.

The transition from the lower to the middle stages of barbarism is marked in the eastern hemisphere by the domestication of animals; in the western by the cultivation of maize and succulent plants by irrigation, together with the use of adobe and stone in house architecture. The upper status of barbarism is cut off from civilisation by the invention and use in the latter of a phonetic alphabet and the art of writing.

In respect to the effect of arts of subsistence in modifying the improvement of mankind, Mr. Morgan takes very broad views. He is of the opinion that success in multiplying the sources and amount of food decided the question of man's supremacy on earth. His advance has been identified with improvement in this particular.

Prof. Burt G. Wilder, of Cornell University, read papers on the following natural history subjects:—Notes on the American Ganoids (*Amia*, *Lepidosteus*, *Acipenser*, and *Polyodon*); The Use and Morphological Significance of the Caudal Filament of the young *Lepidosteus*; The Embryology of Bats; The Affinities and Ancestry of the existing Sirenia. This paper was based upon three specimens which were exhibited. First, a fœtal Dugong, 2½ feet long, obtained from Australia through Prof. H. A. Ward. Second, a fœtal Manatee, between three and four inches long (as if extended), obtained from South America through Prof. James Orton. Third, a fœtal Cetacean (probably

Porpoise), three inches long (as if extended), lent to Prof. Wilder by Mr. Alex. Agassiz, Curator of the Museum of Comp. Zoology at Cambridge. The last two specimens are believed to be the smallest of their kind hitherto recorded.

Prof. Wm. S. Barnard, of Canton, Ill., read a paper *On the Development of the Opossum, Didelphys virginiana.*—Prof. Barnard read another paper, in which he compared the muscles of man with those of the higher apes, showing the points of similarity as well as of difference. An interesting point made in this paper was the statement that one of the buttock muscles supposed to be peculiar to the higher apes, distinguishing them from man, really existed in the human body and in a similar position. It was shown that the muscle thus described by Traill, and afterwards by Wilder as in the chimpanzee, and by Owen and Bischoff as in the orang, and by Coues as in the opossum, is also found in man, and offers no distinction in this respect. Three new muscles about the hip-joint, found in the orang and some other apes, were also made the subject of description; these muscles have no homologues in man. Two of these act to rotate the leg and draw it inward; the other seems too small to have any functional value and is probably a rudiment, but is interesting as occurring also in some of the lower apes and the opossum. The other muscles in this region of the body were like those of man, but in the case of an orang the short head of the biceps of the thigh was found entirely separated. This is only occasionally the case with the orang, and this peculiarity is not known to exist in any other animal. The two large external muscles of the calf do not unite with each other to form a single tendon Achillis, consequently in the orang this tendon is double, which sometimes occurs with marsupials. These investigations, which were explained in much technical detail, tend to prove that all the muscles possessed by man can be traced backward in the lower forms of animals, through the apes to the lemuroids.

Prof. Barnard gave a detailed account of his observations on the *Protozoa*, made in the anatomical laboratory of Cornell University, Ithaca, N.Y., where the specimens described were also seen by Prof. Wilder and others than the investigator himself.

Prof. George F. Barker, of Philadelphia, read a paper *On the Cause of the Relative Intensity of the Broken Lines of Metallic Spectra.* The purpose of this paper is to give the general result of a series of measurements made to ascertain, by Vierordt's method, the relative intensity of these various lines, and to compare these with their lengths measured micrometrically. Vierordt's method consists in measuring the intensity of a coloured light by the amount of white light necessary to extinguish it. By means of a third telescope attached to the spectroscope, a bright slit of light may be thrown upon any portion of the spectrum, and by varying the distance of the source of this light, until it extinguished the various spectrum lines in the order of their brightness, a series of numbers was obtained which, by the law of the inverse squares, gave the relative intensity of the different spectrum lines. The metals experimented upon were copper, gold, silver, antimony, bismuth, and magnesium. The general result is, that in no case does the length of the spectrum line follow the law of brightness. Hence some other hypothesis must be suggested to account for the phenomena. The author suggested one which seemed to him to be at least possible, and to be sustained by the prevalent views on molecular and atomic physics. The constitution of a gas is simple; the molecules composing it move in straight lines, and encounter each other and the walls of the containing vessel in so complex a way that Prof. Maxwell doubts if mathematics can follow their paths. The oscillations of the atoms within the molecule, are, however, less complex; they either are simple harmonic motions themselves, or they may be resolved into such. It is these harmonic vibrations which, communicated to the ether, cause the spectrum lines; the number of the different forms of oscillation constituting the number of lines in the spectrum, the period of any one oscillation determining the wave length of the corresponding line, and the amplitude fixing the brilliancy of that line. These things being granted, we have only to suppose what is perfectly conceivable, that the amplitude of the vibration, the only point we are now concerned with, varies with the temperature differently for each of the different kinds of vibration in the molecule, or, what is the same thing, with the wave length. If, for example, the peculiar harmonic vibration of the atoms of a copper molecule which gave the longest line in the green, diminished the amplitude of its oscillation less rapidly than the one in the blue, then this is a sufficient reason why it should be the longest. We may, therefore, by inspection of a broken spectrum, conclude at once on the rapidity with which the amplitude of the different harmonic vibrations of the atoms within the molecule decreases with decreasing temperatures, this being simply in the order in which the lines are arranged as to their length. This is offered as a working hypothesis to be proved or disproved by special investigation. From the facts already known it may be regarded as antecedently probable. It seems to be a step taken into the great field lying between chemistry and physics, at present a great and unexplored gulf. Work done here cannot be thrown away even if done to test an untenable hypothesis. It must bear fruit, though it may be very different in kind from that anticipated.

REPORT ON THE PROGRESS AND CONDITION OF THE ROYAL GARDENS AT KEW DURING THE YEAR 1874

FROM Dr. Hooker's recently issued report on the progress and condition of the Royal Gardens, Kew, for 1874, we learn that a series of lectures, or, as they are called in the report, "practical lessons," have been given to the gardeners during the evenings, after working hours. These "lessons" embrace the elements of structural, systematic, and physiological botany; of chemistry, physical geography, and meteorology, in their application to horticulture; of economic botany, forestry, &c. They are given, some in the young men's Library, others in the Garden or Museum. Notes of these lessons have to be taken by those attending them, which, after being fairly written out in notebooks, are examined periodically by the teacher and corrected, or more explicit instruction given if necessary. The attendance at these lessons is voluntary, but the fact of "good attendance" is recorded in every gardener's certificate of conduct and proficiency on his leaving the service of the establishment.

These lessons have been instituted with the view of the better education of the gardeners in subjects bearing upon their profession, so as to qualify them for "Government and other situations in the Colonies and India, where a scientific knowledge of gardening, arboriculture, &c., is required." Most of the colonial gardens and Government plantations are at the present time under the superintendence of able men, who received at some time or another instruction at Kew.

The liability of *Coffea arabica* to the attack of both insects and fungi have been abundantly proved of late by the visitation of the so-called blights in Dominica, Southern India, and more recently in Ceylon. In consequence of this a good deal of interest is attached to the prosperity of the Liberian Coffee, which has been distributed from Kew. On this subject Dr. Hooker says: "A large stock of true Liberian Coffee has been obtained through the kind efforts of Messrs. Irvine and Woodward, of Liverpool. This is a larger and perhaps different variety from that received from Cape Coast. . . . Large quantities of both have been sent to the coffee-growing British possessions, and have arrived in excellent condition. Dr. Thwaites states that the Cape Coast Coffee, the safe arrival of which in Ceylon I mentioned in the report of last year, is, notwithstanding that it was immediately attacked by the leaf disease, doing well. He also remarks that 'the Cape Coast and Liberian Coffees, although they would seem to differ much as regards size of their respective seeds, yet in the matter of foliage there is great resemblance between them. In this latter respect they differ considerably from the ordinary coffee plant of Ceylon, their leaves being a good deal larger, more firm in texture, and tapering more gradually to the base.'"

The increased cultivation of coffee, and the introduction of varieties better suited to resist the attacks of disease, has, it appears, attracted the attention not only of the British Government, but also of the Colonial Governments, so that a good deal of correspondence has arisen with Kew on the subject. Dr. Hooker says: "My attention has in consequence been directed (1) to obtaining accurate reports as to the nature of the disease, of which several are confounded under one common epithet; (2) to recommending measures for the cultivation of coffee in colonies once famous for its production where it has been almost abandoned, as well as in others where the cultivation has been scarcely attempted; and (3) to the cultivation of new and improved varieties."

The Blue Gum Tree (*Eucalyptus globulus*), which has now become so popular that plants some twelve or fourteen feet high may be seen growing in the open air in some of our London parks, is recommended for planting by Dr. Hooker, simply on